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Improved processing of precious metal-containing materials

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(71) Applicant(s)
GRD Minproc Limited

(72) Inventor(s)
Mark Cadzow

(74) Agent/Attorney
Allens Arthur Robinson,Patent and Trade Marks Attorneys,Stock Exchange Centre,530 Collins Street,MELBOURNE VIC 3000

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ABSTRACT

The invention provides a method for recovery of precious metal from a leaching solution containing complex precious metal cyanides including the steps of:

(a) adding a blinding agent to the leaching solution;

(b) contacting the product of step (a) with an adsorbent to adsorb the precious metal complex onto the adsorbent; and

(c) recovering the precious metal from the adsorbent.

AUSTRALIA

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ORIGINAL

COMPLETE SPECIFICATION

STANDARD PATENT

Invention title: **Improved Processing of Precious Metal-Containing Materials**

The following statement is a full description of this invention, including the best method of performing it known to us:

Field of the invention

This invention relates to an improved process for the recovery of precious metals.

In particular the present invention relates to an improved process for recovery of gold, silver, platinum and/or palladium by cyanidation of materials bearing these metals.

More particularly, the improved process of the present invention is intended for use in the recovery of gold and other precious metals by cyanidation accompanied by recovery of the gold-cyanide complex by means of in-pulp adsorption onto added activated carbon or ion exchange resins, such means commonly being known as the carbon-in-pulp and the resin-in-pulp processes, respectively.

In this specification, where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date:

(i) part of common general knowledge; or

(ii) known to be relevant to an attempt to solve any problem with which this specification is concerned

Background of the invention

Precious metals, especially gold, have traditionally been leached from an ore or other precious metal-containing material using an alkaline cyanide solution. The precious metal goes into solution in the form of a metal-cyanide complex. The recovery of the solubilised precious metal is often accomplished by addition of a granular adsorbent to a slurry of the precious metal-containing feed material to which the alkaline cyanide solution has been added. The precious metal-cyanide complex is adsorbed by the granular adsorbent from which is can be subsequently recovered. By this means a more concentrated form of the precious metal-cyanide complex can be obtained, from which the precious metal itself can be ultimately recovered.

For clarity, the background art and the invention will be further described with reference to gold recovery, rather than recovery of precious metals in general. However it is to be understood that the invention is not limited to gold recovery but may also be advantageously used to recover other precious metals.

Some gold-containing materials, such as ores and concentrates, or ores and concentrates that have been subjected to a pretreatment process such as roasting, pressure leaching or bacterial oxidation, contain components that are capable of adsorbing the gold-cyanide complex from a leach slurry. This undesirable adsorption is commonly known as preg-robbing. The preg-robbing components in a gold-containing feed may vary in nature and can include various forms of natural carbonaceous material. Where preg-robbing components are present in the gold containing feed, a reduced amount of the gold-cyanide complex is adsorbed onto the added activated carbon or resin acting as the granular adsorbent for gold recovery. The balance of the gold-cyanide complex is adsorbed onto the preg-robbing components in the feed and ultimately reports to the tailings dam. This material is lost from the process. Thus the overall gold recovery is substantially less than the theoretical maximum.

Various procedures have been proposed to overcome the deleterious effects of this preg-robbing behaviour. One such procedure involves the addition of a suitable chemical, known as a blinding agent that is capable of adsorbing onto the surface of the preg-robbing component(s) in the feed material. This procedure results in a decrease in the amount of gold-cyanide complex adsorbed by the preg-robbing component(s). To date this procedure has had limited success, partly because the blinding agent is often adsorbed onto the granular adsorbent (such as activated carbon or resin) used for recovery of the gold-cyanide complex. That is, the blinding agent generally is non-selective in its behaviour.

Without wishing to be bound by theory, it is believed that the blinding agents attach themselves to the preg-robbing components in the feed material by chemical and/or physical means. One example of such action might be the attachment of a large organic molecule to the natural carbonaceous material in the feed. The greater the size or hydrophobicity of the reagent, the greater the likelihood of physical attachment.

Conversely, the greater the size, the more difficult to adequately disperse the reagent in the aqueous feed slurry so that the reagent can attach itself to the appropriate sites on the carbonaceous material.

One way in which this problem can potentially be reduced is by the addition of dispersants or emulsifying chemicals to aid the dispersion of the organic components in the aqueous phase of the feed slurry. However, these chemicals may also enhance the detachment of the blinding agent(s) from the carbonaceous material during subsequent

processing, and may themselves contribute to deactivation of the granular adsorbents used for in-pulp recovery.

Description of the Invention

The present invention provides a method for recovery of precious metal from a leaching solution containing complex precious metal cyanides including the steps of:

(a) adding a hydrophobic organic blinding agent to the leaching solution using high shear mixing;

(b) contacting the product of step (a) with an adsorbent to adsorb the precious metal complex onto the adsorbent; and

(c) recovering the precious metal from the adsorbent.

Typically the leaching solution is formed by leaching a feed material containing one or more of the following precious metals, gold, silver, platinum and paladium. The feed material is leached by an aqueous cyanide solution to form a precious metal complex with the cyanide. Typically the feed material is a run of mine ore, concentrate or products from various pre-treatment steps such as pressure oxidation, roasting and bacterial oxidation although other suitable feed materials containing precious metals are also suitable for use in the method provided by the present invention.

The blinding agent may be a hydrophobic organic blinding agent suitable for reducing the preg-robbing characteristics of any component of the feed material or the leaching solution. Preferably the blinding agent is composed entirely of a light hydrocarbon fraction such as naphthas, kerosene or gasoline.

Kerosene is a particularly preferred blinding agent and is well known to those skilled in the relevant technology as a thin mineral oil whose density is between 0.75 and 0.85 g/cc. A mixture of hydrocarbons, it is commonly obtained in the fractional distillation of petroleum as the portion boiling off between 150 and 275 °C.

Kerosene has the advantage of being readily available and of low cost and therefore does not adversely effect the cost effectiveness of the recovery of precious metals.

The blinding agent may be aromatic or non-aromatic but is preferably of a physical configuration complementary to that of the adsorbent. Typically the adsorbent is a carbon

based adsorbent. The nature of the adsorbent used will vary with the process. For example, the harsher the leaching process, the more robust the physical form of the adsorbent. When the adsorbent used is of a graphitic structure, the blinding agent is preferably of a substantially rod-lie or planar configuration.

Once it has been used in the process, particulate carbon such as carbon fines may be filtered off and cleaned up before being recycled in the process.

Hydrophobic organic blinding agents such as kerosene are not ordinarily miscible with the aqueous environment of the leaching solution. It has been found that the effects of the blinding agent in reducing preg-robbing can be enhanced by forming a dispersion of the blinding agent in the leaching solution prior to contacting the solution with the adsorbent.

Most preferably the blinding agent is added to the feed material via an in-line mixer. The mixer is preferably a form of high shear mixer which facilitates dispersing the blinding agent in the leaching solution. In-line high shear mixing devices are particularly suitable for use in accordance with the present invention. Mixtec and Filbast in-line high shear mixers are specifically designed for enhanced dissolution-dispersion of components into an aqueous feed slurry system and are particularly suitable for use in accordance with the present invention.

The precious metal may be recovered from the adsorbent in known manner. It has been found that the application of the present invention to a carbon in pulp recovery system or resin in pulp recovery system has advantages both in the amount of gold recovered and also in the relatively low usage of a relatively economical material as a blinding agent.

In a particularly preferred arrangement, the present invention therefore provides a method of significantly reducing the preg-robbing characteristics of gold containing feed materials including run-of- mine ores, concentrates and products from various pre-treatment steps such as pressure oxidation, roasting and bacterial oxidation by the addition of an organic blinding agent such as kerosene preferably by means of an in-line high shear mixing device.

One of the advantages of high-shear mixing is that it does not cause excessive agitation of the slurry. Froth formed by excessive agitation tends to encapsulate particles of precious metal, thus removing it from the leaching process and reducing overall process yield of precious metal. For this reason use of high shear mixing is preferable to aggressive agitation of the blinding agent and slurry using impeller or blade mixers.

The results obtained by high-shear mixing devices used in commercial operations cannot be readily replicated in the laboratory. Even so, the results obtained in laboratory scale testing clearly demonstrate the efficiency of the present invention for reducing the preg-robbing behavior of certain components within the feed materials. The optimal composition and addition rate of the blinding agent both depend upon the nature of the precious metal-containing feed material and the pre-robbing component(s) of that feed. It will be readily apparent to those skilled in the art that addition rates and other operating parameters of the present invention are highly dependent on the chemical and mineralogical properties of the feed material.

Examples

The invention will now be described with reference to the following non-limiting examples in which Comparative Example, Examples 1 and 2 provide laboratory test results and Example 3 provides the results of plant trials. In neither example have the blinding addition rates or other operating parameters been fully optimised. The addition rates and operating parameters noted in the examples are merely illustrative of the invention generally and correspond to specific feed materials but do not necessarily apply to other feed materials. In general, the mixing processes used to obtain the laboratory test results would not be practical for use in a commercial operating plant; they are merely illustrative of the beneficial results obtained by intimate mixing of the blinding agent with the feed material.

Comparative Example

Ore containing 3.3 g/t gold was made into a slurry containing 40% solids, and leached for 24 h in a 8 kg/t sodium cyanide solution containing 30 g/t activated carbon. At the end of the leach period, the amount of gold adsorbed onto the activated carbon was equivalent to 52% of the amount present in the ore before leaching. The sodium cyanide

consumption was 2.70 kg/t feed. The low recovery of gold onto the activated carbon is indicative of the preg-robbing nature of the feed.

Example 1

The process described in Comparative Example was then repeated using the same ore as feed material, with the exception of the addition of 500 mg/l kerosene to the slurry. The slurry was vigorously stirred for three hours to disperse the kerosene throughout the leach pulp in order for the kerosene to interact with the preg-robbing components of the feed. For convenience, this three-hour period is termed the conditioning period. Sodium cyanide and activated carbon were then added to the kerosene containing slurry. Following the 24 h leach period, the sodium cyanide consumption was 2.68 kg/t feed, that is, the consumption was the same as in the Comparative Example. There was no significant change in sodium cyanide consumption as a result of the addition of kerosene to the leach pulp and the three-hour conditioning period. Analysis of the activated carbon recovered following the 24 h leach stage showed that 87.2% of the gold in the original feed had been adsorbed onto the activated carbon. That is, the addition of the well-dispersed kerosene as a blinding agent resulted in an increase of 35% of the total amount of gold recovered onto the activated carbon.

Example 2

The feed for this example was derived from an operating processing facility in which a gold-containing sulphide concentrate was first subjected to pressure oxidation prior to cyanidation. The pressure oxidation step is used to chemically destroy the sulphide minerals that are the host of the contained gold. The sulphide concentrate itself is highly preg-robbing. The washed slurry from the pressure oxidation step contained 22.5 g/t gold.

In the first series of tests, the procedure described in Comparative Example and Example 1 were used to ascertain the effectiveness of the kerosene as a blinding agent. In these tests, the kerosene addition rate was 250 mg/l slurry. Analysis of the activated carbon and the leach residue (CIL residue) showed that the average gold content of the tailings was reduced from 3.79 g/t to 2.06 g/t when the kerosene treatment was applied.

Example 3

An operating plant was used to repeat the process of Example 2 using the same feed materials.

An in-line Mixtec mixing device was incorporated into the circuit of an existing operating plant for precious metal leaching, to enable kerosene to be rapidly dispersed into the washed post-oxidation slurry pipeline as the slurry was being transferred to the carbon-in-leach circuit. In on-going, continuous plant trials over 8 weeks, analysis of the plant CIL residues showed that the average gold content was reduced to 1.97 g/t. That is, the plant trials replicated the data obtained in the laboratory-scale tests described in Example 2. The reduction in the gold content of the CIL residues results in a substantial increase in the overall gold recovery and thus the economic viability of the entire processing facility.

The word 'comprising' and forms of the word 'comprising' as used in this description and in the claims does not limit the invention claimed to exclude any variants or additions.

Modifications and improvements to the invention will be readily apparent to those skilled in the art. Such modifications and improvements are intended to be within the scope of this invention.

The claims defining the invention are as follows:

1. A method for recovery of precious metal from a leaching solution containing complex precious metal cyanides including the steps of:

(a) adding a hydrophobic organic blinding agent to the leaching solution using high shear mixing;

(b) contacting the product of step (a) with an adsorbent to adsorb the precious metal complex onto the adsorbent; and

(c) recovering the precious metal from the adsorbent.

2. A method according to claim 1 wherein the leaching solution is formed by leaching a feed material containing a precious metal chosen from the group containing gold, silver, platinum, paladium and combinations thereof.

3. A method according to claim 2 wherein the feed material is chosen from the group comprising mine ore, concentrate from a mineral processing pre-treatment step or product of a mineral processing pre-treatment step or combinations thereof.

4. A method according to any one of the preceding claims wherein the hydrophobic organic blinding agent is

a light hydrocarbon fraction.

5. A method according to claim 4 wherein the blinding agent is kerosene.

6. A method according to any one of the preceding claims wherein the adsorbent is chosen from the group comprising graphite and activated carbon.

7. A method according to any of the preceding claims wherein the blinding agent is of a physical configuration complementary to that of the adsorbent.

8. A method according to claim 7 wherein the adsorbent is of a graphitic nature and the blinding agent is of a substantially planar configuration.

9. A method according to claim 8 wherein the adsorbent is graphite and the blinding agent is kerosene.

10. A method according to any of the preceding claims wherein step (a) includes forming a dispersion of the blinding agent in the leaching solution prior to contacting the product of step (a) with the adsorbent.

11. A method according to any one of the preceding claims wherein the product of step (a) is added to the feed material using high shear mixing.

12. A method according to any one of the preceding claims wherein the method is applied to a carbon in pulp recovery system or resin in pulp recovery system.

13. A method according to any one of the preceding claims wherein between 50% and 99% of precious metal in step (a) is adsorbed onto the adsorbent.

14. A method according to any one of the preceding claims wherein between 70% and 90% of precious metal in step (a) is adsorbed onto the adsorbent.

15. A method according to any one of the preceding claims wherein between 80% and 90% of precious metal in step (a) is adsorbed onto the adsorbent.

16. Precious metal recovered by the process according to any one of the preceding claims.

17. A method according to claim 1 and substantially as herein described with reference to the examples.

GRD Minproc Limited **14 October 2005**